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Calculus for software engineering: Students' perception towards flipped classroom

S K Ummah[1], R D Azmi[1] and N Shofia[2]

[1]Universitas Muhammadiyah Malang, Kampus III, Jl. Raya Tlogomas 246 Malang 65144, Indonesia
[2]Universitas Nusantara PGRI Kediri, Jl. KH. Ahmad Dahlan 76, Kediri 64112, Indonesia

E-mail: khoiruliummah@umm.ac.id

Abstract. The research aimed to analyse the learning readiness and perception of informatics engineering students about calculus. More top-level students taken remedial teaching and the student stated that calculus was dominated by mathematics and lecturers did not relate to software application. The research method which was a case study analysed the learning readiness was further examined by providing an open questionnaire to new students about the calculus learning. The lecture was then carried out as many as 4 meetings. The overall research data was a description of the questionnaire and quiz results. The questionnaire stated that 82% of new students have not yet learned that calculus belongs to the field of mathematics. After lectures using flipped classroom models were implemented, the quiz results show that 38 students reached a score of more than 80. Students also respond positively to the learning using flipped classroom models increased the spirit of learning calculus because all records and exercises were well stored and can be downloaded at any time. Learning using flipped classroom models provided easy learning for new students, practicality in task collection, and effectiveness for communicating with lecturers and group members without being tied to place and time.

1. Introduction

Mathematics is studied by some fields of study, including engineering. One of the subfields of engineering who studied mathematics in the first year is informatics engineering. Informatics using mathematics to cover calculus, discrete mathematics, numerical methods, and programming. The calculus then becomes the basic courses are given to students in the first year. In calculus, the contents include the system of real numbers, functions, limit, derivative, and integral. As for the application of the material of calculus, namely the calculation of distance, speed, and acceleration of a moving object, the area of the polygon, and the volume of rotating objects.

Informatics Engineering students have a wide range of background interests. Not all informatics engineering students came from vocational schools in informatics major. Student of Informatics Engineering at UMM in particular, comes from a science major, specialization in network computer engineering, and informatics.

Student of informatics engineering in the first year must take the basic courses of mathematics including calculus and discrete mathematics. Calculus is important to be studied as basic science techniques. Sensitivity analysis of the network and the optimization has an important role in informatics, and requires a mathematical approach to the hang of it. Functions for sensitivity analysis and optimization require considerable time to be resolved manually. Therefore, the necessary computer

programming to make the operating time of the network becomes shorter [1].

Informatics engineering students have a different educational background. This study Program may be selected by the high school students and vocational school. The things that became the main requirement of this study program, namely the minimum limit of passing score test and a background stream. High school students may take a program of study that is of the science specialization. Students coming from vocational secondary schools can choose programs of study that specialization techniques. Study Program of informatics engineering at UMM 2019 accept 240 students divided into 6 classes. Engineering information needed by different types of companies [2, 3]. Therefore, prospective students who are interested in this field very much. Background specialization in school is important to support the skills lectures. Informatics has qualifying skills, among others, interpersonal skills, teamwork, problem solving, and technical skills in the field of software [4, 5]. This is what into consideration the basic requirements of admission of new students. In contrast, not all students come from informatics major. It is dominated by students with specialization in sciences, machine, industrial, and automotive. Thus, they didn't have technical skill, specifically in software knowledge.

This study focused on the difference in the success of learning non-academic calculus for new students of informatics engineering. Success is measured from the results of the non-academic which include self-regulated learning and motivation. These three things are included in the critical to degree completion in addition to GPA [6]. The success of learning and non-academic is influenced by the education system prevailing in the university. Students who do not have at least one indicator of the success of non-academic hereafter referred to as students at risk and vice versa.

Self-regulated learning is a process of self-regulation which encourages students actively participating in learning and is measured from the skills task completion [7]. Indicators of self-regulation, among others, student involvement in learning in the form of active participation and the presence of hard effort to be active during the learning. Active participation can be measured from activities of question-and-answer. Self-regulated can also be measured through problem-solving strategies of students [8]. Problem-solving strategies can also be measured from the type of computer application used by the student to resolve the problem. Self-regulation is beneficial to give feedback learning based on the response of the students [9, 10]. Strategy selection learning methods become important thing to do and one of them can be motivated by self-regulation.

In addition to self-regulated learning, motivation plays an important role in achieving the success of the non-academic during the learning takes place. Motivation is able to make students become self-learner and the achievement of learning outcomes of academic skills [11]. Motivation can be in the form of the readiness to learn of students, willingness to learn, interested in the challenge, and the usefulness of the material [12]. Motivation related to learning outcomes, academic achievement, and perceptions of students [13]. he results of the previous research stated that there is the influence of motivation and self-regulated learning to learning calculus [9, 10, 14, 15]. The influence between motivation and self-regulated learning is based on the method of learning that is problem-based learning [16] and the approach of the student profile [7]. Therefore, an investigation of motivation and self-regulated learning is important for investigation.

Based on the experience of lecturers in the learning of calculus for new students of informatics engineering in the previous year, the involvement of the informatics engineering students for learning calculus to be a challenge for lecturers. This is because that students take a first-year student so not yet familiar with each other. When the lecturer gives questions, students are still shy to answer so that the lecturer should have pointed with how to call a student's name randomly. Method small group discussions conducted also has not shown the desire of students to express opinions. Discussion is done in a group by dividing the matter with the members of the group. This resulted in the process of discussion has not been seen among the members of the group. This is in line with previous research which states that the assignment to the students of engineering could not be said to be successful because the students have the nature of closeness with a particular partner if the partner is different to matter is not resolved well [16].

The problem can be resolved one way is to change the method of learning. The method of learning that is exciting, innovative and meet the elements of the novelty is expected to increase courage and self-confidence of students to express their opinions. One of the innovative learning methods and in accordance with the objectives of 21st century learning which emphasizes on the use of technology, namely blended learning.

Blended learning is an approach that reduces the frequency of face-to-face in the classroom and

replace them with online learning [17–20]. Blended learning can be used to integrate learning through face-to-face with an online system using computing technology in the form of the application [21]. This resulted in learning that was originally the use of learning-oriented versus teacher turned into a learning-oriented students as well as to the teacher [22]. The second approach combined also is a combination of face-to-face interaction that utilizes the help of technology between the students, lecturers, and teaching materials electronically.

Blended learning has several kinds of models to be applied. This model is distinguished from the stages of implementation of blended learning. One of the models implemented in this study is a model of flipped classroom. Flipped classroom does not leave the traditional learning which is dominated by the teacher but the traditional learning is integrated with assignments online [23]. More it is said that the learning that takes place in the classroom should not be dominated by an explanation by the teacher but rather with the activity of the collaborative using the method of scaffolding by the teacher. This means that, flipped classroom divide the student learning activities into two, namely independent learning and group learning [14, 24]. Independent learning is done when students access the LMS outside of the classroom [25]. Students download the material in the form of e-modules and then try to complete the exercises. Learning groups do in the classroom [26]. Teachers provide reinforcement in the form of exercises that be solved in groups [27]. In-class discussions facilitated by the teacher in the form of a question-and-answer with a small group, review the learning video that has been watched the students through the LMS, the discussion is classical, and the presentation of the progress of the project [25]. Thus, the flipped classroom basically can be implemented by different methods especially at the time of learning in the class. The core of the flipped classroom: learning is done by way of face-to-face and online alternately.

This study aims to analyze the perception of students of the new department of information engineering, when engaged in blended learning with a type of flipped classroom. Perception is measured of self-regulation and motivation of new students. The focus of this research is to change the perception of students in terms of student background with specialization in different.

2. Method

2.1. Research design

The case study investigates new student in study program of informatics, which is involved in learning calculus using a blended learning approach type of flipped classroom. Qualitative data obtained from the open questionnaire. The question that is used as a reference for the research, namely:

- How to change the motivation of new students of informatics engineering program that are involved in blended learning during the learning?
- How to change self-regulated students new engineering program that are involved in blended learning during the learning?

Case studies produce a complete description of the student's perceptions of the new informatics to a blended learning type of flipped classroom so that the reader can retrieve the information needed. This case study contains limitation of the subjects a total of 43 students involved in blended learning. The subject of which is hereinafter referred to as the participants fill out the questionnaire about the perception.

First, observations and interviews were conducted to identify problems in the calculus class of engineering students. The results of observation subsequently formulated the main problem for the analyzed factor is the cause and results of the implementation of the learning model. The Blended learning model was chosen using the model of the flipped classroom. It is based on the Regulation of the Rector of UMM, Number 01 Year 2019 on the implementation of blended learning using the LMS Canvas. LMS canvas has been developed by the IT UMM so domain canvas has turned into umm.ac.id. After set the classes on the LMS, further developed the material and tasks to be uploaded on the LMS. Second, the design of the research instrument includes questionnaire and observation sheet in the form of field notes. A questionnaire developed referring to the indicators of the perception is the load self-regulation and motivation. The open-questionnaire contains a list of questions, they are: 1) views about mathematics, 2) the experience of mathematics in school, 3) study habits while in high school, 4) the learning preparation, 5) views about calculus, 6) lecture system online, 7) changes to the learning system, 8) the feeling of attending lectures online, 9) an active role in group discussions, and 10) ease

of access to the LMS. The results of the questionnaire and the observation sheet were described for comparison with previous research. This case study discusses the extent to which the feasibility study with the model of the flipped classroom and describe the perceptions of engineering students the first year about online learning.

2.2. Participants

Fifty -engineering students in University of Muhammadiyah Malang provided a pool of participants for the investigation. The anonymity of the schools was preserved by using pseudonyms. The involved students in the study participate to take a questionnaire. The students filling questionnaire completely were analysed. Only 7 students were able to participate in the study. Students were observed in learning.

The researcher had provided a broad description of at-risk to the lecturer. The lecturer, therefore, classified 7 students as at-risk for many identifications. Wahyu is a student from high-school and disabled learning student in discussion. Riski and Dwi are female students from vocational high school and difficulty in number calculation. Nur and Ahmad are the male students from vocational high school who did not complete their homework. Dama is female student from science major in high school who displayed difficulty in math course. Rizal is a male student from automotive major in vocational high school who always come late and has a lack of motivation.

2.3. Data collection method and instruments

The data in this study were qualitative data. They were questionnaire and students' comments in LMS. The collected data reached from open-questionnaire and observation.

The instruments used were the questionnaire that presented in Table 1.

Table 1. Questionnaire Form

Aspects	Questions
Views about math	You have learned math in school. Tell me what do you think about math.
The experience of mathematics in school	During learning math in school, especially high school, described the experience of learning mathematics in the school.
Study habits while in high school	Mathematics makes a person has a different habit. Tell the habit of learning the math you do in high school.
Learning preparation	The learning preparation is one of the factors for the learning of mathematics. Before participating in learning mathematics, describe the preparation of what you do.
Views about calculus	The word 'calculus may be the first time you listen. After the first meeting, tell me what you think about calculus.
Online lecture system	Online learning system conducted by lecturer might be a new learning experience. Explain in your opinion about online learning.
Changes to the learning system	After studying mathematics in school that emphasize on the teacher explanation, how do you feel about changes in a learning system that turned into online.
Feeling of attending lectures online	Tell me how you feel about online learning for calculus.
Active role in group discussions	Tell me about your experience and your opinion about the changes in behavior during the discussion takes place online.
Ease of access to the LMS	Describe your experience using the LMS starting from the registration, the activation of courses to the online discussion.

Table 1 showed the detailed question that has been written in questionnaire form. The students have to fill the form completely using description text.

2.4. Data analysis

In this research, the process of data analysis began using the questionnaire data. The data is reduced and selected the most complete. The results of the questionnaire were given highlights on the information considered important and relevant to the research question. Having obtained the complete data and appropriate research questions, questionnaire form was collected to be described in each question. Description further reinforced by the description of the results of observation when online learning takes place. Data taken from the number of comments on the LMS and for learning in the class.

3. Results and discussion

Informatics engineering student showing interest towards online learning conducted during four meetings. Interest is shown through the response of the students during the lectures increased. Students were enthusiastic in expressing an opinion and dare to ask during the lesson. Some of the opinions of students are reinforced with the results of observation shows how students are interested to engage in the settlement of a matter, asked a friend when the discussion takes place in class and online, to give an opinion when another friend delivered the answer, download the material before the learning in the class, want to try the exercises first, and want to immediately follow the lecture calculus.

When a lecture that took place, there are some comments from students about the implementation of the lecture online. Nur stated "the lectures in class to be easy to follow because the material is already delivered through the LMS, I can learn it first." Agree with Nur, Wahyu said "can I try the exercises first before the lecture in class so that I can answer questions in class". Dama said "I like online learning because I am free to comment without face-to-face directly." Ahmad argues different with Dama that "I prefer learning in a classroom rather than online because I am free to ask directly to your friends and lecturers". Dwi and Riski is like the given problem and stated "I'm interested in solve all types of problems because each student has different answers".

Student comments during the lesson showed that the interest towards learning calculus. Students feel comfortable to express opinions, write down the different answers with other friends, interested in listening to comments and answers to another friend, and have the preparation of a good learning before the learning in class.

3.1. Self-regulation and blended learning

The first aspect of the perception of the students who observed that self-regulation. Self-regulation is emphasized in this study namely self-confidence in problem solving, self-reliance in obtaining information, learning readiness, and engagement in group discussion. The investigation was conducted by giving the questionnaire and reduce the relevant data.

Confidence in problem solving especially in the learning of calculus with the blended-learning approach is analyzed from the results of questionnaires and observation. Dwi derived from the vocational high-school is able to solve problems in the form of exercises and discussion groups. "The questions that are given makes me interested to finish it. The given problem is very unique because of the numbers that appear customized with the date of my birthday, my mother or digit of NIM. I am challenged to see the results of the work of my friends". Dama also had the similar opinion. "I was very challenged to try the practice problems in the house before the learning takes place in class. Learning in class makes me dare to show the answers of the exercises I had done in the house before."

As many as 6 students agree that through learning blended make students independent in learning and solving problems. Riski revealed the "learning at school has restricted access, i.e. books students. Learning calculus using online learning to have flexible time and facilitates me in finding the references that are relevant to solve the problems." The same thing also expressed by Rizal, "my previous drape homework answers to a friend. Now, the exercises that are given before the class begins make me

interested in trying it yourself and if can't be done, I usually upload screenshots of my work then I share through a group discussion online."

The readiness of the study stated students with a way of expressing the activity which is done before the lecture begins. Nur derived from the concentration technique of the computer network and rarely do the work of the house, said "house work makes me have the time to play the game short. Homework that is usually given when the school contains a collection of questions that are rarely discussed in class. Through online learning, I am challenged to finish all the homework. This is because each homework will be discussed in class. The lecturer used to call at random who presented the answer. I am very happy because of the work the house does not need my copy from a friend, if I trouble direct can I ask through online discussion forums." Ahmad, who rarely complete homework is also stated "I prefer to copy the answer to a friend because I was lazy of working on many problems. However, homework given online make I didn't can cheating answers friends because every problem contains numbers that depend of the date of my birth. If I cheating is surely not in accordance to the data myself". Dama stated different with other friends. "I like online learning because it can be flexible to be accessed at any time. I have constraints in terms of the internet network. When I access LMS, I was immediately interested pay attention to the discussions that took place. I can learn in advance what discussed friends then I follow the discussion."

Seven students stated that learning blended make students discuss in group. Wahyu did not initially like the discussion declared "the online discussion makes me not shy in expressing an opinion. I don't need to meet face to face with your group of me. In the end when learning in the classroom, I'm used to convey my opinion, ask a friend group and to the lecturer." In addition, Rizal during studying in school rarely use the discussion said that "the discussion this time is different because the discussion has been given earlier in the LMS so we have to learn it first at home. We also have the usual discuss in advance online. The lecturers are very helpful to us during the discussion make me comfortable in the discussion." Dwi stated "the discussion made me interested to follow it up with how to provide comments, ask questions, and I feel free to release opinions as well as I do when chatting with classmates in Whatsapp group. The lecturer also did not rebuke the comments we are using everyday language. Friends feel comfortable to comment on each other. Even at the end of the matter, before the post-test, the number of comments on the online discussion forums we reached hundreds of comments. No one blame the other answers but we used to ask why can obtain different answers with us."

The results of the questionnaire about self-regulation suggests that students have different ways in the following online learning with the preparation of a better learning. Students more confident and independent in solving problems that is usually given through homework and discussion. Students are initially not familiar with the learning methods discussion feel comfortable and confident in expressing an opinion. Learning in class and online showed the students the unusual answer the question your friends and professors began to appear on the online discussion forums. Students feel comfortable with the online discussion, which then become a regular active discussion in class.

3.2. Motivation and blended learning

The second aspect was analysed by the aspect of motivation. The motivation referred include aspects of the opinion of students about mathematics, calculus, online learning, change of approach to learning, and LMS are used. During the lesson, the students also observed at once given the question about the opinion of the implementation of online learning.

The opinion of students about mathematics is not good enough. As many as five students stated that mathematics is a subject that does not want to be followed during school. Dwi argue "mathematics fraught with memorizing the formula. One formula that I cannot remember makes me fail in learning." Similar things expressed by the Dama "I don't like math. Math teacher at the school is very fierce and likes to punish students if not doing homework." Dwi also argues "I feel strange if math learned in the classroom with discussion system. I drape a friend group I to complete the material for discussion. But if the teacher explains I like sleepy in class. Nur stated "mathematics in my school less attractive. Problem given the teacher contained in the student book. About also there are already examples of the

solution in the example problems so we just cheating the procedure of its completion." Different with other students, Riski said "I like mathematics but which concerns the application at a concentration of my knowledge. I like the application of mathematics in informatics, for example when related to network optimization and the use of the binary number. Unfortunately, when I was in school rarely learning math gives you problems about the application."

Different with the mathematics that is already known to the students since elementary school, calculus is the new term for some students. Nur stated that "I was shocked when the calculus is a math lesson in the field of engineering. Math again and again. I think when I became a student of informatics, I will not meet again with the math. It turns out I was wrong because calculus is the mathematics and in them is full of material that I had learned earlier in school." The same thing also expressed by the Dama, "a Calculus about the system of real numbers, functions, limit, derivative, and integral. I feel like a failure when knowing that these courses mostly discuss about the mathematics." Rizal expressed his opinion "I already know from friends that the calculus of mathematics. I am not surprised and hope that this course is more directed to applications of calculus in the field of informatics. Approach to learning calculus should be changed so that what is learned is the application limit, a derivative and an integral in the field of network optimization." Ahmad stated "I hope that teaching calculus is different with the character of the math teacher I am demanding the memorizing the formula and understand how to use it. Technology is getting advanced, preferably calculus not just calculate and draw the chart but rather how to use the formula to be applied in the field of informatics. In addition, the graph can easily be drawn using the app or the calculator should be discussed how to give the meaning on the chart."

The opinion of the students was positive when aspects of online learning are discussed. Ahmad proclaims "online learning is very new for me. I can be flexible to follow the discussion anytime and anywhere. I also learn from the opinions of friends who use everyday language that is easily understood." This is in line with the opinion of the Dama "online Discussion that followed the exercises in class made me more understand the material calculus. Initially, I was not fond of the calculus became interested because learning requires me to access the applications of mathematics and have always been interested waiting for the date material for discussion." A little different with the opinion of the Nur "My constrained internet network so that I follow online learning in their free time. UMM policy on blended learning followed by the addition of the speed of internet access on the hotspot in the heart of the lecture. It is very helpful to me to follow the online learning well." Rizal argues "online learning makes easy for students to access the material and be confident in expressing opinions online. In addition, online learning can make time for discussion of homework are becoming longer and the discussion carried out can include a lot of numbers about different."

Change in learning approach from conventional to blended learning provide positive change for the students. As many as 6 students agree that the change in the approach of blended learning make the students have positive thoughts about mathematics, in terms of this calculus. Dama stated that "blended learning is very different with the teaching and learning conducted by my teacher during the lecture. My teacher really like explained on the board while we asked noted. We get tired and sleepy to listen to it. Online learning makes us very ready to learn and learning in the classroom more done activity homework discussion." Ahmad also agreed that "I prefer online learning because I have a lot of time searching for the information about the about the settlement and the settlement discussion. The time available to learn more and more and challenged me to search from the internet. If the reference settlement discussion material in the form of video, I directly give the URL of the video on Youtube so with the embed code, friends don't need to download the video and can be listened to together."

The opinion of the students about LMS used can be used as a reference for the policy of LMS that are practical to implement. The opinion of students is to a level of technical use of the LMS as a website provider of online learning services. Riski stated "LMS Canvas used is very different with Edmodo. Edmodo have a good layout because it resembles Facebook. Edmodo can also be accessed through Android so if there are comments, the assignment can be directly known through a notification on the phone." Nur agreed with Rizal "I like Edmodo because of the ease in accessing the application. Comments can also be seen as a whole and not time-limited." Different with Ahmad "LMS Canvas is

able to load the LaTEX and Math equation making it easier for me to answer the questions directly on the comment column. Different with Edmodo, I have to convert first to the form of LaTEX and then I post with a specific format." Dama stated "LMS Canvas has a feature that the discussions are time-limited, if we access the forum discussion outside the limited time then the forum does not appear. In addition, if there is a maintenance of the university, we lose information on the part of the discussion. Edmodo has the use of the stable to be accessed. The Menu on the Edmodo very efficient to use in learning. However, for the sake of learning Calculus, the LMS Canvas plays a very predominant for the writing of the equation.

3.3. Summary

The study aimed to describe blended learning implementation and how the informatics engineering students set up learning calculus and participation in learning. This study identifies the important components related with the success implementation of blended learning in informatics engineering student. This study investigated students based on two aspects, namely self-regulation and motivation. Researchers using questionnaire and observation to observe the students ' perceptions of calculus using a blended learning approach.

Researchers describe the relationship between the perception of informatics engineering students towards blended learning. Perception is based on self-regulation and motivation based on the results of the questionnaire which shows not a lot of students who love math. Even some of the students claimed to be surprised when the calculus is a course about mathematics.

The results showed that through online learning with a blended learning approach using the model of the flipped classroom makes the students have the readiness to learn which is better marked than the activity of students in online discussion. Students also want to try practice problems before the discussion in class. In addition, the self-confidence of students is very strong when argued in the online discussion forums which can then be accustomed to convey your opinion on learning in the classroom. This is in line with previous research that states the habit of expressing an opinion starting from the virtual discussions that do not ask members of the group face-to-face [8, 17, 26]. It was the uniqueness of the findings of this case study that through learning blended learning, students have an interest to listen to the answers to your other because the questions on the practice problems are different from each other. Students also have an interest when requested looking for a reference online and then vying for the URL of the video that is relevant to the problem which is then commented on by other friends. Another finding is the freedom of speech using the local language so that students are more comfortable listening to the explanation a friend rather than an explanation formal by the lecturer.

The results of further research about the motivation of students in learning calculus. Motivation is very good look from the perception of students about mathematics and calculus actually the dreaded and boring. Students are interested in learning calculus that emphasizes the application and use of formulas in the field of informatics. Students are fond of the application that is able to accommodate their comments to write down the equation easily. In addition, online learning has the attractiveness from the aspect of the ease, practicality, and attractiveness of the display. The perception of online learning which is positive, make the students ' learning motivation increased. This is in line with previous research stating that online learning makes students interested to download the material first and then the flexibility to access learning [8, 20, 28]. However, it is different with the results of the research about Karlsson [29] which states that learning blended learning allows students to cheat off other work. The findings of this study indicate the use of the problems that set numbers are calculated with the birth date the student makes the student could not cheat with other friends. In addition, the findings of the study are the change in the perception of students about mathematics and calculus, if taught according to the application in the field will add to the attraction and the spirit of learning.

4. Conclusion

The implementation of blended learning using a flipped classroom does not leave the conventional learning models. Lecturer full control on the course of learning calculus. The perception of the students

of informatics engineering which is based on self-regulation has significant changes, especially related to student involvement in group discussions and learning readiness on learning in the classroom. The perception of informatics engineering students based on motivation showed significant changes in aspects of students ' perspectives about mathematics and the calculus the first lesson that is not liked to be learning forward and make curious. Curiosity is aimed at the applications of mathematics in the field of informatics and is manifested through the activities of the search the URL of the video to be shared and commented on other friends online.

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